

POSITRONIUM FORMATION IN 2s STATE IN  $e^+$ -Li SCATTERING

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There are ample theoretical reasons to investigate  $e^+$ -alkali atom scattering. Moreover, recent measurement on  $e^+$ -alkali atom system by Detroit group<sup>1</sup> has renewed much interest for investigating these processes. Here we study positronium (Ps) formation in excited 2s state in  $e^+$ -Li scattering at intermediate and high energies including second order effects following Basu and Ghosh<sup>2</sup>. Guha and Saha<sup>3</sup> have calculated the excited ns state capture cross sections using FBA at several incident energies ranging from 10-500 eV. It is well-known that FBA or any other first order approximation is not suitable to describe a rearrangement process at high energies since it is the second Born approximation to which the cross section converges. To our knowledge, no other work has yet been performed to predict excited state positronium formation cross sections in  $e^+$ -Li scattering.

In the conventional perturbative approach, the capture ampli-

tude retaining upto the second order term, from the ground state  $\langle \nu |$  of Li atom with momentum K to the excited state  $|\nu'\rangle$  of the Ps atom with momentum  $K'$  is given by

$$g_{\nu', \nu}(K', K) = g_{\nu', \nu}^B(K', K) + g_{\nu', \nu}^{B2}(K', K) \quad (1)$$

where,  $\nu$  stands for 2s state of Li atom and  $\nu'$ , 2s state of Ps atom. Here  $g_{\nu', \nu}^B(K', K)$  is the first Born excited state capture amplitude and  $g_{\nu', \nu}^{B2}(K', K)$  is the second order amplitude and is given by

$$g_{\nu', \nu}^{B2}(K', K) = \frac{1}{2\pi^2} \sum_{\nu''} \int \frac{dK''}{K''^2 - K_{\nu''}^2 - i\epsilon} \times g_{\nu', \nu''}^B(K', K'') f_{\nu'', \nu}^B(K'', K) \quad (2)$$

$f^B$  being the first Born scattering amplitude. The summation over  $\nu''$  runs over the discrete eigenstates of the target atom.

The use of closure relation in evaluating the rearrangement second order term is unsatisfactory. In the present calculation we assume that the valence electron is the active electron i.e. Ps atom is formed with the valence

electron only. We retain two target eigenstates, 2s and 2p, as intermediate ones. We have used the reliable Hartree-Fock wavefunction of Weiss<sup>4</sup> for ground and excited states of Li atom.

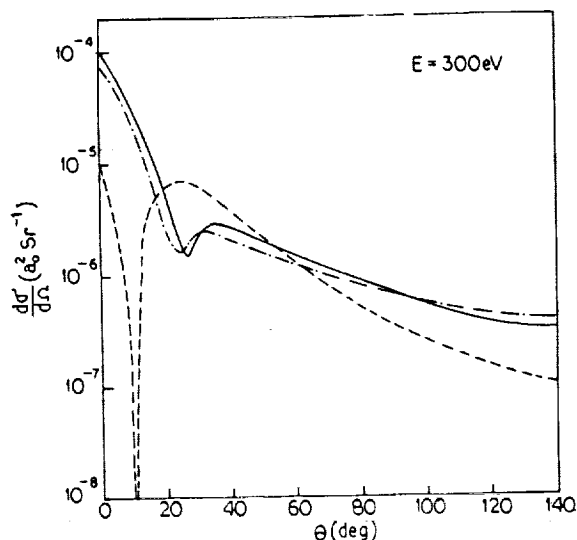


Fig.1. DCS ( $a_0^2$ ) for excited 2s state capture in  $e^+$ -Li scattering at 300 eV. --, FBA; -.-, SBA (with 2s intermediate); —, SBA (with 2s 2p intermediate)

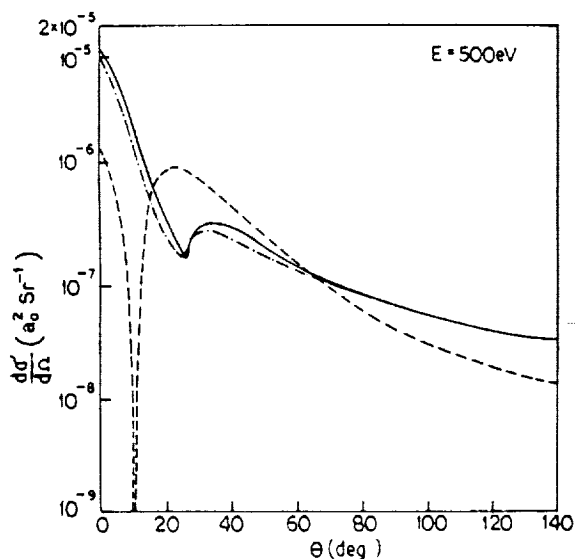


Fig.2. Same as in Fig.1 at 500 eV.

In Figs.1 and 2, we report our differential cross sections at two incident energies, 300 and 500

eV respectively. It is known that the second Born term is of vital importance in determining the asymptotic behaviour of the capture cross section. The contribution of the second Born term is found to be appreciable at 300 eV. With the increase of energy, the contribution decreases. The first Born DCS attains zero value around  $10^\circ$  at both the energies as the two parts of the amplitude are of opposite sign and cancel each. Contribution of the second order term prevents the total cancellation in the DCS and the residual structure is due to the destructive interference of the amplitudes. The SBA structure is found around  $30^\circ$ . These features have also been obtained by Basu and Ghosh.

The convergence of  $g^{B2}$  is of key importance. We could not test the convergence by increasing the higher target states as intermediate ones. The detailed results will be reported in the near future.

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